THE MYCORRHIZAL ASSOCIATIONS OF AUSTRALIAN INULEAE (ASTERACEAE)

by

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ABSTRACT

Warcup, J. H. The mycorrhizal associations of Australian Inuleae (Asteraceae). *Muelleria* 7(2): 179–187 (1990). Some Australian Asteraceae form both ectomycorrhizal and vesicular-arbuscular mycorrhizal (VAM) associations; however, other species form only VAM. All Australian species known to form ectomycorrhiza appear to belong to the Inuleae, although the tribal relationships of *Isoetopsis graminifolia* Turcz. and *Chondropyxis halophila* D. A. Cooke have been subject to debate. Present data, although incomplete, suggest that in revised genera of Australian Inuleae all species have the same mycorrhizal system. An exception may be *Podotheca s.str.* The data suggest that knowledge of mycorrhizal association may be useful in considering relationships of taxa at generic and other levels.

INTRODUCTION

Warcup & McGee (1983) reported that some Australian Asteraceae, both in the field and in the laboratory, form both ectomycorrhizal and vesicular-arbuscular mycorrhizal (VAM) associations whereas other species are solely VAM. Species forming ectomycorrhizas were usually placed in the tribe Inuleae. The only exception *Isoetopsis graminifolia* Turcz. has also recently been referred to that tribe (Bremer 1987). Elsewhere reports of Asteraceae forming ectomycorrhizas are uncommon (Harley & Harley 1987) and are based on field data. The Australian data raise questions as to why some Asteraceae may form dual mycorrhizal associations (Ecto. + VAM) and whether in heterogeneous genera such as *Helichrysum* and *Helipterum* (Merxmüller, Leins, & Roessler 1977) the type of mycorrhizal association correlates with taxonomic relationship. The results of further investigations on the mycorrhizal associations of endemic Australian Inuleae are reported here.

METHODS

Evidence of mycorrhizal association was obtained mainly by growing seedlings of Inuleae inoculated with specific fungi, either ectomycorrhizal or VAM, in pots of an autoclaved sand-soil mix low in available phosphate. Soil-mix, method of inoculation and test fungi were generally those used previously (Warcup & McGee 1983). The unidentified ascomycete WARH24 was the main ectomycorrhizal fungus and *Glomus microcarpum* Tul. & Tul. the VAM partner. With a few species, notably *Podotheca angustifolia* (Labill.) Less., *Gnephosis sp. aff. skirrophora* and *Waitzia citrina* Steetz, a wider range of ectomycorrhizal fungi, including *Peziza whitei* (Gilkey) Trappe, *Labyrinthomyces varius* (Rodway) Trappe, *Elaphomyces* sp., *Tomentella* sp., *Laccaria ohiensis* (Mort.) Singer and *Sebacina vermifera* Oberwinkler (Warcup 1988b), were used successfully in ectomycorrhizal experiments.

Mycorrhizal experiments were done in a controlled growth room with a 12 hr day, a day temperature of 22° C and a night temperature of 18° C. The photosynthetic photon irradiance of 245 μmol $m^{-2}s^{-1}$ was measured at plant level under a bank of 15 Phillips TLK 65/80 W 33RS white tubes. All species formed VAM. Where possible ectomycorrhizal experiments were repeated if the original test was negative, but where few seedlings were available this was not always possible.

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RESULTS

While the mycorrhizal associations of Australian Inuleae were examined in general, work was concentrated on two groups the *Angianthus* group (*sensu* Merxmüller *et al.* (1977) and the *Helichrysum-Helipterum* complex. The first group of about 35 species is endemic in Australia and is concentrated in Western Australia with only a few species widespread across southern Australia. Most are annuals living in semi-arid to arid environments often on the margins of saline depressions (Short 1983). The *Helichrysum-Helipterum* group contains some 600 species mainly in Africa,Eurasia and Australia. The Australian species, about 160, are all or mostly endemic (Cooke 1986). They range from annual herbs to large shrubs, are widely distributed and occur in a wide range of habitats.

Table 1 gives data on mycorrhizal associations of the species of Inuleae investigated. Approximately 180 species representing 55 of the *c.* 80 inuloid genera currently recognised in Australia were examined.

Individual genera or generic groups are further discussed below but it is evident that the following general conclusions can be made:

a. usually only single or dual mycorrhizal associations occur in any one genus; very often such genera have been recently revised [*e.g. Actinobole* (Short 1985), *Angianthus* (Short 1983), *Blennospora* (Short 1987b) and *Streptoglossa* (Dunlop 1981)]. *Podotheca*, also recently revised (Short 1989a) seems to be an exception.

b. where both dual and single systems have been observed in the one genus, *e.g. Helichrysum* and *Helipterum*, the genus is usually well known to be a heterogeneous assemblage of species. Almost invariably, suggested segregate genera contain species with onc type of mycorrhizal association, *i.e.* the data are useful for suggesting relationships of taxa.

DISCUSSION

ANGIANTHUS *s. lat.*

This genus was revised by Short (1983, 1989b). All tested species in *Angianthus s. str.* have dual mycorrhizal systems, as do the monotypic, segregate genera *Cephalosorus, Fitzwillia* and *Sondottia*. In contrast, other segregate genera examined (*Dithyrostegia, Epitriche, Hyalochlamys, Lemooria, Pogonolepis* and *Siloxerus*) are solely VAM.

GNEPHOSIS

This is an artificial genus. An array of inflorescence characters strongly suggests that a number of segregate genera should be recognised (Short 1987, pers. comm.) and this is reflected by the mycorrhiza data.

Gnephosis s. str. (*sensu* Short 1987) only contains species with the dual system, as do the four species of the segregate genus *Trichanthodium* (Short 1990). On the other hand *G. arachnoidea*, which should probably be referred to *Nematopus* A. Gray, is solely a VAM species. Thc placement of other single system species has not been entirely clarified although the inclusion of *G. pygmaea* with some species of *Myriocephalus* (probably *Myriocephalus s. str.*, see Short *et al.* 1989) is supported by the data.

PODOLEPIS

Investigations by Short *et al.* (1989) clearly show that this is also an unnatural genus although all species investigated have the dual mycorrhizal system.

PODOTHECA

This genus, recently revised (Short 1989a), has one species, *P. chrysantha*, which is solely VAM whereas the others are ectomycorrhizal + VAM. Seedlings were tested with isolate WARH24 on three separate occasions with the same result. There seems no doubt that this is a natural genus and further tests with different ectomycorrhizal fungi are desirable (Warcup 1988a).

Calocephalus

This is an unnatural group and a number of segregate genera should be recognized (Short 1986). *Blennospora* has already been reinstated (Short 1987b) and it only contains species with the dual mycorrhizal system, unlike tested species of *Calocephalus* (with the possible exception of *C. angianthoides*), which only have the VAM system. Similarly *C. brownii* (VAM) probably deserves recognition as the distinct genus *Leucophyta* (P. S. Short, pers. comm.).

Helichrysum & Helipterum

It is generally accepted that most, in fact probably all Australian species currently placed in *Helichrysum* and *Helipterum* (both *sensu* Bentham 1867) will be referred to a number of segregate genera (Wilson 1987, Short *et al.* 1989), *e.g. Chrysocephalum* Walp. and *Lawrencella* Lindley. Their establishment is supported by the presence of both single system species and dual system species in both genera, *Helichrysum* and *Helipterum*. Proposed segregate genera (P. G. Wilson, pers. comm.) usually contain species with the same type of system.

Cassinia

There seems little to distinguish between this genus and *Ozothamnus* Benth. [in which many shrubby species of *Helichrysum* should be placed (P. G. Wilson, pers. comm.)]. It is perhaps significant that the species of *Cassinia* only have VAM systems, as do the ozothamnoid species of *Helichrysum*.

Myriocephalus

The genus, as circumscribed by Bentham (1867), is clearly unnatural (Short *et al.* 1989) and this is reflected in the mycorrhiza data. *M. gracilis*, the only dual system species noted, has affinities with species currently included in *Helipterum* (P. S. Short, pers. comm.).

Chondropyxis & Isoetopsis

Chondropyxis halophila was included by its author (Cooke 1986) in the Anthemideae but with the comment that, along with *Ceratogyne* Turcz., *Dimorphocoma* F. Muell. & Tate, *Elachanthus* F. Muell. and *Isoetopsis* it had closer affinities with the Astereae. Robinson and Brettell (1973) also considered that *Isoetopsis* was a member of the latter tribe, and not the Anthemideae in which it has been traditionally placed (Bentham 1867). On the other hand Turner (1970), on the basis of chromosome data, suggested that *Ceratogyne* and *Isoetopsis* might best be placed in the Inuleae. Bremer (1987) also remarked that unpublished work suggested that *Isoetopsis* is a member of the Inuleae (Subtribe Pluchiinae). The placement of *Chondropyxis* and *Isoetopsis* in the tribe Inuleae is supported by the mycorrhiza data as Australian members of other tribes of the Asteraceae do not seem to form ectomycorrhizas (Warcup & McGee 1983).

The data were collected to investigate whether in genera in the Inuleae considered taxonomically homogeneous all species had the same mycorrhizal system, *i.e.* all formed only VAM or all formed VAM and ectomycorrhizas. As all species investigated, and probably all species of Asteraceae, may form VAM, the important question is which species form ectomycorrhizas. The test used added fresh young mycorrhizal roots as inoculum of a test fungus to the tap root of a host seedling during transplanting to an autoclaved soil mix low in available phosphate. Where the host is capable of forming ectomycorrhizas fungal hyphae from the inoculum grow on to the roots and usually rapidly form ectomycorrhizas whose presence is indicated by increased growth of the host compared with uninoculated plants. Later the host is harvested and the roots checked for the presence of ectomycorrhizas. With time it became apparent that this was a simplistic approach to whether species may form mycorrhizas. While there appears little specificity of association between hosts and fungi there is great variation in the number of mycorrhizas formed under different conditions (Warcup 1988a). Thus absence of mycorrhizas in a single test does not necessarily indicate whether a host is incapable of forming ectomycorrhizas. For this reason negative tests were repeated where possible but due to lack of material some species that form ectomycorrhizas may have been incorrectly assigned as solely VAM species. Whether all VAM species may, under certain conditions, form ectomycorrhizas is unknown. However, a few VAM species that were widely tested and observed in the field were always VAM; further, many species that form ectomycorrhizas formed them regularly in the presence of ectomycorrhizal fungi.

In families such as the Pinaceae and Fagaceae, which are consistently ectomycorrhizal (Harley & Harley 1987), all species in a genus form ectomycorrhizas. A few cases are known, however, where only one species in a genus not normally considered to be ectomycorrhizal has been reported with ectomycorrhizas in the field. Such reports are often with *Cenococcum geophilum* Fr. possibly because of its easily visible black hyphae. As this fungus may grow over the surface of roots of many plants it is difficult to assess in the absence of experimental work whether it forms functional ectomycorrhizas, i.e. gives host growth responses with the hosts with which it has been associated.

In the Asteraceae *Mycelis muralis* (L.) Dumort has one record of ectomycorrhiza in association with *C. geophilum* (Harley & Harley 1987). Also Read & Haselwandter (1981) found *Homogyne alpina* (L.) Cass. had some black ectomycorrhizal roots at one of three alpine sites in Austria at which "*Dyras octopetala* L. possessed typical ectomycorrhizas many of which were of the *Cenococcum* type and dominance of mycelium of this kind was reflected in the presence of fungi of this type on a number of herbaceous species." Without further information it is difficult to assess whether formation of ectomycorrhizas in *H. alpina* was a response to environmental conditions rather than being an innate character of the species. In the Australian studies, however, while individual plants of ectomycorrhizal species may form ectomycorrhizas, VAM or both in the field (Warcup & McGee 1983; McGee 1986) most species are consistently ectomycorrhizal, often with a range of fungi, in ectomycorrhizal syntheses in the laboratory.

What governs whether a species may form ectomycorrhizas remains obscure. Warcup (1988a) in the Australian Lobelioideae showed that perennial species were solely VAM whereas annual species of *Lobelia* and *Isotoma* formed both ectomycorrhiza and VAM. Thus no simple correlation occurred between mycorrhizal system and the characters presently used in classification. There is no correlation between mycorrhizal systems and whether plants are annuals or perennials in the Inuleae. An alternative explanation that species forming ectomycorrhizas are those that occur predominantly in habitats where other ectomycorrhizal hosts are abundant seems difficult to substantiate on present ecological data (Short 1981, 1983; Cooke 1986). Genera with solely VAM species, such as *Siloxerus, Ozothamnus* and *Pteropogon* may be common in habitats where other ectomycorrhizal hosts such as *Eucalyptus, Melaleuca, Casuarina* or *Acacia* are common. The limited data here, like the data for pines, oaks and beeches suggest a taxonomic, possibly genetic basis.

Table 1. Check-list of the occurrence of mycorrhiza in Australian Inuleae

Genus	Total No. species	Species Investigated	Source*	Mycorrhiza
ACTINOBOLE Fenzl. *ex* Endl.	4	*A. condensatum* (A. Gray) P. S. Short	Short 1005	VAM
		A. uliginosum (A. Gray) Hj. Eichler	Short 827	VAM
AMMOBIUM R. Br.	1	*A. alatum* R. Br.	McGee	?VAM

Genus	Total No. species	Species Investigated	Source*	Mycorrhiza
ANGIANTHUS Wendl.	15	*A. acrohyalinus* Morrison	Short 1000	Ecto
		A. cunninghamii (DC.) Benth.	KP5730	Ecto
		A. drummondii (Turcz.) Benth.	KP5732	Ecto
		A. glabratus P. S. Short	Short 838	Ecto
		A. micropodioides (Benth.) Benth.		Ecto
		A. preissianus (Steetz) Benth.	Short 842	Ecto
		A. milnei Benth.	KP5740	Ecto
		A. tomentosus Wendl.	Short 1028	Ecto
APALOCHLAMYS Cass.	1	*A. spectabilis* (Labill.) J. H. Willis	L. D. Williams 10237	?VAM
ASTERIDEA Lindley	7	*A. athrixioides* (Sond. & F. Muell.) Kroner	Short 1756	Ecto
		A. pulverulenta Lindley	KP5758	Ecto
BELLIDA Ewart	1	*B. graminea* Ewart	Short 2176	VAM
BLENNOSPORA A. Gray	2	*B. drummondii* A. Gray	Short 1030	Ecto
		B. phlegmatocarpa (Diels) P. S. Short	Short 1077	Ecto
CALOCEPHALUS R. Br.	±14	*C. angianthoides* (Steetz) Benth.	Short 1043	VAM
		C. francisii (F. Muell.) Benth.	KP5793	VAM
		C. platycephalus (F. Muell.) Benth.	KP5799	VAM
CASSINIA R. Br.	±18	*C. laevis* R. Br.	JHW	VAM
		C. aculeata (Labill.) R. Br.	JHW	VAM
		C. arcuata R. Br.	JHW	VAM
CEPHALIPTERUM A. Gray	2	*C. drummondii* A. Gray	KP5817	VAM
CEPHALOSORUS A. Gray	1	*C. carpesioides* (Turcz.) P. S. Short	Short 2403	Ecto
CHONDROPYXIS D. A. Cooke	1	*C. halophila* D. Cooke	Haegi 2565	Ecto
CHTHONOCEPHALUS Steetz	4	*C. pseudevax* Steetz	KP5812	VAM
		C. sp. aff. tomentellus	Short 2111	VAM
CRASPEDIA Forst. *f.*	±20	*C. chrysantha* (Schl.) Benth.	JHW	VAM
		C. globosa (Bauer *ex* Benth.) Benth.	JHW	VAM
		C. pleiocephala F. Muell.	JHW	VAM
		C. uniflora Forst. *f.*	JHW	VAM
CRATYSTYLIS S. Moore		*C. subspinescens* (F. Muell. & Tate) S. Moore	KP5835	VAM
DECAZESIA F. Muell.	1	*D. hecatocephala* F. Muell.	Short 2049	VAM
DITHYROSTEGIA A. Gray	2	*D. amplexicaulis* A. Gray	Short 2398	VAM
EPALTES Cass.	4	*E. cunninghamii* (Hook.) Benth.	Badman 1722	VAM
EPITRICHE Turcz.	1	*E. demissus* (A. Gray) P. S. Short	Short 2391.	VAM
ERIOCHLAMYS Sond. & F. Muell. *ex* Sond.	1	*E. behrii* Sond. & F. Muell. *ex* Sond.	Short 833	Ecto
FITZWILLIA P. S. Short	1	*F. axilliflora* (W. V. Fitzg. *ex* Ewart & J. White) P. S. Short	Short 2188	Ecto
GNAPHALIUM L.	±30	*G. involucratum* Forst. *f.*	JHW	VAM
		G. japonicum Thunb.	JHW	VAM
GNEPHOSIS Cass. *s.str.*	6	*G. tenuissima* Cass.	Short 999	Ecto
		G. multiflora (P. S. Short) P. S. Short	Short 1046	Ecto
		G. trifida (P. S. Short) P. S. Short	Short 966	Ecto
		G. drummondii (A. Gray) P. S. Short	Short 1068	Ecto
		G. uniflora (Turcz.) P. S. Short	Short 1026	Ecto
GNEPHOSIS *s. lato.*	±17	*G. brevifolia* (A. Gray) Benth.	Haegi 2652	Ecto
		G. gynotricha Diels	Short 2031	VAM
		G. foliata (Sond.) Hj. Eichler	ADW59615	VAM
		G. macrocephala Turcz.	Short 1022	VAM
		G. arachnoidea Turcz.	ADW59615	VAM
		G. eriocarpa (F. Muell.) Benth.	Short 2997	VAM
		G. acicularis Benth.	Short 1015	Ecto
		G. pygmaea (A. Gray) Benth.	Haegi 2640	VAM

Genus	Total No. species	Species Investigated	Source*	Mycorrhiza
HELICHRYSUM Mill.	±100	*H. cordatum* DC.	KP5873	VAM
		H. bracteatum (Vent.) Willd.	CBG	Ecto
†'Lawrencella'		*H. davenportii* F. Muell.	KP5874	VAM
'Lawrencella'		*H. lindleyi* Hj. Eichler	KP5881	VAM
'Lawrencella'		*H. ayersii* F. Muell.	KP5868	VAM
'Lawrencella'		*H. subulifolium* F. Muell.	KP5890	VAM
†'Ozothamnus'		*H. antennaria* (DC.) Benth.	Tas.	VAM
'Ozothamnus'		*H. dendroideum* Wakef.		VAM
'Ozothamnus'		*H. diosmifolium* (Vent) Sw.	ADSG	VAM
'Ozothamnus'		*H. obcordatum* (DC.) Benth.	Tas	VAM
'Ozothamnus'		*H. rogersianum* J. H. Willis	ADSG	VAM
'Ozothamnus'		*H. paralium* (N. T. Burbidge) W. M. Curtis	ADW47852	VAM
'Ozothamnus'		*H. ledifolium* (DC.) Benth.	ADSG	VAM
'Ozothamnus'		*H. hookeri* (Sond.) Druce	ADSG	VAM
'Ozothamnus'		*H. cuneifolium* Benth.	ADSG	VAM
'Ozothamnus'		*H. diotophyllum* F. Muell.	ADSG	VAM
†'Chrysocephalum'		*H. apiculatum* (Labill.) DC.	JHW	Ecto
'Chrysocephalum'		*H. semipapposum* (Labill.) DC.	ADSG	Ecto
'Chrysocephalum'		*H. ramosissimum* Hook.	McGee	Ecto
		H. ambiguum Turcz.	ADSG	?VAM
†'Blepharolepis'		*H. rutidolepis* DC.	McGee	VAM
'Blepharolepis'		*H. milliganii* Hook. *f.*	Tas	VAM
'Blepharolepis'		*H. podolepidium* F. Muell.		VAM
		H. scorpioides Labill.	JHW	VAM
		H. blandowskianum Steetz *ex* Sond.		Ecto
		H. dealbatum Labill.	CBG	Ecto
†'Leucochrysum'		*H. leucopsideum* DC.	McGee (1986)	Ecto
		H. baxteri Cunn. *ex* DC.		Ecto
HELIPTERUM DC.	±60	*H. manglesii* (Lindley) Benth.	Short 2153	VAM
		H. tenellum Turcz.	Short 2286	VAM
'Chrysocephalum'		*H. pterochaetum* (F. Muell.) Benth.	ADW55506	Ecto
†'Pteropogon'		*H. corymbiflorum* Schldl.	JHW	VAM
'Pteropogon'		*H. humboldtianum* (Gaudich.) DC.	KP5913	VAM
'Pteropogon'		*H. pygmaeum* (DC.) F. Muell.	KP5927	VAM
'Pteropogon'		*H. microglossum* (F. Muell *ex* Benth.) Maiden & Betche	ADW59639	VAM
'Pteropogon'		*H. troedelii* F. Muell.	ADW59392	VAM
'Pteropogon'		*H. anthemoides* (Sieber *ex* Sprengel) DC.		VAM
'Pteropogon'		*H. chlorocephalum* (Turcz.) Benth.	Wilson 12299	VAM
'Pteropogon'		*H. roseum* (Hook.) Benth.	KP5929	VAM
'Pteropogon'		*H. splendidum* Hemsl.	KP5932	VAM
'Pteropogon'		*H. strictum* (Lindley) Benth.	Short 1581	VAM
'Pteropogon'		*H. oppositifolium* S. Moore	Wilson 12273	VAM
†'Monencyanthes'		*H.* sp.*aff. condensatum*	Short 2064	VAM
'Monencyanthes'		*H. maryonii* S. Moore	Haegi 2644	VAM
'Monencyanthes'		*H. uniflorum* J. Black	ADW45444	VAM
'Monencyanthes'		*H. moschatum* (Cunn. *ex* DC.) Benth.	ADW59335	VAM
†'Cephalipterum'		*H. sterilescens* F. Muell.	KP5933	VAM
		H. verecundum S. Moore	Wilson 12354	Ecto
		H.?spicatum (Steetz) Benth.	Short 2131	VAM
		H. battii F. Muell.	Wilson 12299	VAM
		H. margarethae F. Muell.	KP5919	VAM
		H. craspedioides W. V. Fitz.	Short 2082	VAM
†'Leucochrysum'		*H. albicans* (A. Cunn.) DC.	ADSG	Ecto
'Leucochrysum'		*H. stipitatum* (F. Muell.) F. Muell. *ex* Benth.	Short 2009	Ecto
†'Hyalosperma'		*H. cotula* (Benth.) DC.	JHW	Ecto
'Hyalosperma'		*H. demissum* (A. Gray) Druce	JHW	Ecto
'Hyalosperma'		*H. hyalospermum* F. Muell. *ex* Benth.	Short 1749	Ecto

Genus	Total No. species	Species Investigated	Source*	Mycorrhiza
'Hyalosperma'		*H. jessenii* F. Muell.	ADSG	Ecto
'Hyalosperma'		*H. praecox* F. Muell.	ADSG	Ecto
'Hyalosperma'		*H. venustum* S. Moore	KP5938	Ecto
'Hyalosperma'		*H. zacchaeus* S. Moore	Wilson 12302	Ecto
'Hyalosperma'		*H. pusillum* Turcz.	Wilson 12396	Ecto
		H. floribundum DC.	KP5906	VAM
Hyalochlamys A. Gray	1	*H. globifera* A. Gray	Short 1006	VAM
Isoetopsis Turcz.	1	*I. graminifolia* Turcz.	Short 1764	Ecto
Ixiolaena Benth.	7	*I. supina* F. Muell.	Symon	VAM
		I. brevicompta F. Muell.	Haegi 2090	VAM
		I. chloroleuca Haegi	Haegi	VAM
Ixodia R. Br.	2	*I. achilleoides* R. Br.	McGee	?Ecto
Lemooria P. S. Short	1	*L. burkittii* (Benth.) P. S. Short	Haegi 2651	VAM
Leptorhynchos Less.	10	*L. squamatus* (Labill.) Lessing	JHW	Ecto
		L. waitzia Sond.		Ecto
Leucophyta Cass.	1	*L. brownii* Cass.	McGee	VAM
Millotia Cass.	±5	*M. greevesii* F. Muell.	ADW55211	VAM
		M. tenuifolia Cass.	JHW	VAM
		M. myosotidifolia (Benth.) Steetz	Short 2128B	VAM
Myriocephalus Benth.	±10	*M. stuartii* (Sond.) Benth.		VAM
		M. nudus A. Gray	Short 1004	VAM
		M. guerinae F. Muell.	Wilson 12257	VAM
		M. rhizocephalus (DC.) Benth	JHW	VAM
		M. gracilis (A. Gray) Benth.	Short 1018	Ecto
Pluchea Cass.	±5	*P. tetranthera* F. Muell.	Short 2029	VAM
		P. rubelliflora (F. Muell.) Robinson	Short 2079	VAM
Podolepis Labill. *s. lato*	±20	*P. canescens* Cunn. *ex* DC.	KP6003	Ecto
		P. gracilis (Lehm.) Grah.	KP6006	Ecto
		P. jaceoides (Sims) Voss	JHW	Ecto
		P. muelleri (Sond.) G. Davis		Ecto
		P. lessonii (Cass.) Benth.	Short 2404	Ecto
		P. kendalli (F. Muell.) F. Muell.	KP6007	Ecto
		P. rugata Labill.	KP6011	Ecto
		P. auriculata DC.	Short 2033	Ecto
		P. capillaris (Steetz) Diels	Short 2136	Ecto
		P. tepperi (F. Muell.) D. Cooke	JHW	Ecto
Podotheca Cass. *s.str.*	6	*P. angustifolia* (Labill.) Less.	McGee	Ecto
		P. gnaphalioides Graham	Short 2129	Ecto
		P. chrysantha (Steetz) Benth.	KP6013	VAM
		P. uniseta P. S. Short	Short & Haegi 2642	?Ecto
		P. wilsonii P. S. Short	Short 2298	Ecto
Pogonolepis Steetz	2	*P. muelleriana* (Sond.) P. S. Short	Short 838	VAM
		P. stricta Steetz	Short 1009	VAM
Pseudognaphalium Kirpiczn.	1	*P. luteoalbum* (L.) Hilliard & B. L. Burt	JHW	VAM
Pterocaulon Elliot	6	*P. sphacelatum* (Labill.) Benth. & Hook. *f. ex* F. Muell.	KP6028	VAM
Quinetia Cass.	1	*Q. urvillei* Cass.	JHW	VAM
Quinqueremulus P. G. Wilson	1	*Q. linearis* P. G. Wilson	Short 2172	VAM
Rutidosis DC.	±6	*R. leptorhynchoides* F. Muell.	JHW	Ecto
		R. multiflora (Nees) Robinson	JHW	Ecto
Scyphocoronis A. Gray	2	*S. major* (Turcz.) Druce	Short 2011	VAM
		S. incurva D. Cooke	Short 2001	VAM

Genus	Total No. species	Species Investigated	Source*	Mycorrhiza
SILOXERUS Labill.	3	*S. filifolius* (Benth.) Ostenf.	Short 1056	VAM
		S. humifusus Labill.	Short 1055	VAM
		S. pygmaeus (A. Gray) P. S. Short	Short 1071	VAM
SONDOTTIA P. S. Short	1	*S. connata* (W.. Fitzg.) P. S. Short	Short 1998	Ecto
STREPTOGLOSSA Steetz	8	*S. liatroides* (Turcz.) Dunlop	Symon	VAM
		S. adscendens (Benth.) Dunlop	Symon 14485	VAM
STUARTINA Sond.	2	*S. muelleri* Sond.	Whibley 7826	VAM
TOXANTHES Turcz.	±3	*T. muelleri* (Sond.) Benth.	McGee (1986)	Ecto
		T. sp. aff. muelleri	Short 2353	VAM
TRICHANTHODIUM Sond. & F. Muell. *ex* Sond.		*T. exilis* (W. V. Fitzg.) P. S. Short	Short 2151	Ecto
		T. baracchianum (Ewart & J. White) P. Short	Conn 2537	Ecto
		T. skirrophorum Sond. & F. Muell. *ex* Sond.	Short 2109	Ecto
		T. scarlettianum P. S. Short	Short 2106	Ecto
TRIPTILODISCUS Turcz.	1	*T. pygmaeus* Turcz.	JHW	Ecto
WAITZIA Wendl.	7	*W. acuminata* Steetz.	KP6060	Ecto
		W. aurea (Benth.) Steetz.	KP6061	Ecto
		W. citrina (Benth.) Steetz	KP6062	Ecto
		W. suaveolens (Benth.) Druce	KP6065	Ecto
		W. podolepis (Gaudich.) Benth.	KP6064	Ecto

* Seed from voucher specimens is referred to by collector number or by Herbarium number, KP seed was from the Kings Park (Perth) seed collection, CBG seed is from the National Botanic Gardens (Canberra), and ADSG seed was from members of the Australian Daisy Study Group.
† Segregates as suggested by P. G. Wilson

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